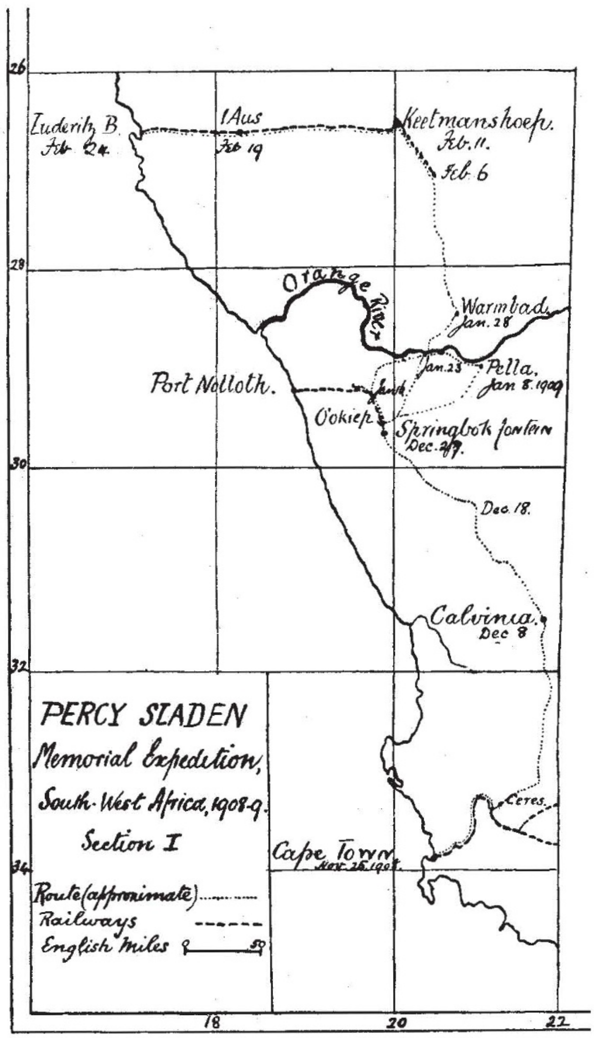
where the vegetation proved to be richer than any hitherto met with. It was said that the rains which had fallen a few months earlier were more copious than any experienced during the previous fifteen or twenty years. It was no doubt a consequence of this that the annual constituents of the flora were unexpectedly abundant. Warmbad is noted for a number of warm springs (35° C.) the waters of which—like so many of the natural waters of the south-west coast—are impregnated with sulphuretted hydrogen. The railway between Keetmanshoep (3300 feet) and the sea ascends to nearly 5000 feet at !Aus, where the vegetation presents many karoid features. From !Aus the descent—at first gradual, later more rapid—is uninterrupted. About 30 km. west of !Aus (110 km. from the coast) the desert commences very abruptly at 2700




feet. In this latitude there appear to be few forms peculiar to the desert itself and its flora consists very largely of the more resistant of the species found at higher levels and under less arid conditions. Nevertheless, the eastern boundary of the desert is remarkably sharp, and approximately coincides with the western limit of precipitation from clouds condensed upon the neighbouring highlands. Within 50 km. of the sea the sharp, bare mountain peaks and ridges are frequently more or less buried in sand-dunes, the materials of which are blown up from the lower-lying flats, leaving behind the worn gravels from which diamonds are now being obtained over an extensive area. Nearer the coast the scenery is remarkably gaunt and rugged and the wind-swept surface is frequently quite bare of vegetation.

Leaving Lüderitzbucht by sea on February 26, I arrived in Swakopmund eighteen hours later, and on March 2 reached Welwitsch (lat. 22°), a Welwitschia locality previously visited in 1907 in company with Mr. E. E. Galpin.[1] The object of this visit was to obtain later stages of the Welwitschia embryo than were present in material collected in 1907. The flora in general was this year very much poorer than two years earlier. Not only were many of the smaller plants then collected not found at all, but woody species formerly obtained in flower or fruit now showed no signs of reproductive activity; this also applies to some extent to Welwitschia itself, for only a small proportion of the plants had coned. The explanation of this very striking difference seems to be contained in the meteorological records. Between[2] November 1, 1906, and January 31, 1907, 12·8 mm. of rain were measured at Welwitsch; in the corresponding period of 1908–9 the rainfall was 5·9 mm. In December, 1906, the fall was 12·5 mm., an amount very much in excess of that recorded for the whole of each of the years 1907 and 1908. We have here, then, another example of the remarkable influence of a small additional rainfall upon both the annual and perennial constituents of a desert flora.

A large number of the Welwitschia plants present in 1907 in this easily accessible locality have been removed in the interval, and, at the same rate, a few years would probably have seen the complete disappearance of all plants from the vicinity of the railway, for there is here no sign of seed-reproduction. It is therefore very satisfactory to note that His Excellency the Acting Governor has issued instructions for the protection of the plants that remain.

H. H. W. PEARSON.

## RESEARCHES ON THE ACTION CENTRES OF THE ATMOSPHERE.[3]

IN the domain of world meteorology, that is, the comparison and discussion of meteorological data of widely distributed stations over the earth's surface, Prof. H. Hildebrand Hildebrandsson has, during the last decade or so, been making some very important communications. He has clearly emphasised the fact that the laws which rule the general movements of our atmosphere will never be found if observations are only made in civilised countries on the earth's surface. Our atmosphere is a mass of air resting both on the continents and the oceans, and modern researches have shown that a large perturbation at one time in one area may be intimately associated with a perturbation of an opposite nature in the antipodal part of the world. Although several workers many years ago intimated the positions of isolated areas which behaved in a reverse or see-saw manner meteorologically, it was Prof. Hildebrandsson who first directed attention to a great number of such areas. In more recent times these isolated instances of barometric see-saws have been found to be part of really one general law applying to the movements of our atmosphere. This general law has yet to be more minutely investigated, for it is, as Prof. Hildebrandsson states, "une verité avec des grandes modifications." There is little doubt, nevertheless, that world meteorology has made a considerable advance since the discovery of these simultaneous reverse-pressure changes, and one is now in a much better position to state where on the earth's surface observations should be made.

Every attempt should therefore be made to utilise islands in the large oceans, even if the sole occupants of the islands are the meteorological observers themselves, for until the air movements over the oceans are carefully observed and recorded we shall still be left to a great extent in the dark.

Prof. Hildebrandsson's most recent memoir deals chiefly with the northern latitudes of the northern hemisphere, and is devoted to a discussion of data with respect to the simultaneous compensation between types of seasons in different regions. The meteorological data here dealt with relate mainly to certain regions between the east coast of

[1] NATURE, vol. lxxv., p. 536.

[2] Meteorological observations at this station were commenced in November, 1906.

[3] Kungl. Svenska Vetenskapsakademiens Handlingar, Band 45, No. 2. III. "Sur la Compensation entre les Types des Saisons simultanés en différentes Régions de la Terre." By H. Hildebrand Hildebrandsson.

North America and Siberia, but some more southern stations are included.

Without going into any great detail, the investigation may be summarised as follows. Prof. Hildebrandsson regards the state of the ice of the polar sea as being the principal cause of the different types of the seasons of different years. Thus a high summer temperature in the arctic sea to the north of Europe will set free a large amount of ice, and consequently the polar current arriving on the north coast of Iceland in February and March, and a branch of which, after skirting the east coast, is directed towards the North Sea, will bring much ice and will be surrounded by a layer of cold water. This current will cool the air in its neighbourhood. The result of the movement southward of these specially cold currents is that the land areas around the Arctic Circle and North Atlantic Ocean suffer *successively* from them by the lowering of their air temperatures. Prof. Hildebrandsson accompanies his statements with tables and an excellent series of curves, which are very convincing. He specially refers to the investigation of M. Peterson, who showed that a variation of 2° or 3° in the surface temperature of the sea is sufficient to create changes of considerable magnitude in the air temperature over very large areas.

The main result of this research is to indicate that in certain cases a means is afforded of making forecasts for seasons. Thus, to take an example, he shows that, with two or three exceptions, in twenty-five years the temperature of the summer at the North Cape was in the following spring in opposition to that of Europe, represented by Debreezin.

## *THE NATURE AND EXTENT OF AIR POLLUTION BY SMOKE.*[1]

IN a former paper read at the Congress of the Sanitary Institute held at Leeds in 1897 an account was given of the quantity of soot suspended in and deposited from the atmosphere of Leeds. It was then shown that, on the average working day, 20 tons of soot are sent into the air of Leeds, of which half a ton falls on an area of four square miles, and of the latter from 20 lb. to 25 lb. stick, that is, are not removable by rain. The present paper contains a record of the atmospheric impurities carried down by rain and the effect of this rain water on vegetation. It also contains an inquiry into the diminution of daylight caused by suspended particles of soot.

Ten representative stations were selected in Leeds and one at Garforth, about 7½ miles due east of Leeds. The impurities, in the form of suspended matter, consist of soot, tar, sand, mineral substances, and, in solution, of sulphurous and sulphuric acids or their salts, chlorides, largely in the form of hydrochloric acid or common salt, and nitrogenous matter, in the form of nitrates or free and albuminoid ammonia. The results are embodied in the following table:—

Analyses of Rain Water, Leeds and Garforth.

*Total for Year, expressed in Pounds per Acre.*

| | Collecting station | Suspended matter | Tarry matter | Mineral matter | Free acidity as $H_2SO_4$ | $SO_3$ | $SO_2$ | Chlorine | Nitrogen as $NH_3$ | Nitrogen as $N_2O_5$ | Nitrogen as albuminoid ammonia | Total nitrogen |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Industrial | 1. Leeds Forge. | 1886 | 110 | 1113 | 35 | 123 | 34 | 164 | 13·0 | 0·0 | 4·7 | 17·7 |
| | 2. Hunslet ... | 1565 | 69 | 655 | 90 | 185 | 24 | 198 | 15·5 | 0·0 | 2·9 | 18·4 |
| | 3. Beeston Hill. | 1163 | 149 | 709 | 30 | 269 | 54 | 101 | 14·4 | 0·5 | 3·5 | 18·4 |
| | 4. Philosophical Hall (Town) | 849 | 78 | 423 | 45 | 149 | 38 | 75 | 14·4 | 0·3 | 2·2 | 16·9 |
| Residential | 5. Headingley.. | 659 | 43 | 199 | 11 | 118 | 32 | 41 | 11·1 | 1·1 | 0·8 | 13·0 |
| | 6. Armley ... | 593 | 34 | 216 | 29 | 110 | 37 | 108 | 9·9 | 1·0 | 3·2 | 14·1 |
| | 7. Observatory. | 399 | 32 | 146 | 26 | 85 | 39 | 51 | 8·4 | 0·8 | 1·6 | 10·8 |
| | 8. Kirkstall ... | 352 | 28 | 141 | 8 | 77 | 56 | 57 | 7·7 | 0·2 | 2·3 | 10·2 |
| | 9. Weetwood Lane | 147 | 26 | 54 | 11 | 82 | 13 | 34 | 8·3 | 1·1 | 2·1 | 11·5 |
| | 10. Roundhay ... | 90 | 14 | 49 | 0 | 53 | 16 | 38 | 5·8 | 0·7 | 1·3 | 7·8 |
| | 11. Garforth (Country) | — | — | — | 28 | 65 | 21 | 22 | 5·0 | 3·2 | 1·1 | 9·3 |

[1] Abstract of a paper by Prof. J. B. Cohen and Mr. A. G. Ruston read at the Health Congress held at Leeds on July 17.

The solid impurities were found to diminish rapidly in passing northwards from the centre of the town. Within the distance of a mile the quantity fell to less than half, and at 2½ miles to less than one-fifth.

The influence of the industrial centres upon the solid impurities stands out most conspicuously, as a glance at the table will show, *i.e.* in the chief industrial centres the solid impurities are roughly twenty times as great as in the purer atmosphere of Roundhay, about three miles north-east of the centre of the town (Fig. 1).

The quantity is also determined by the prevailing winds, which are west, south-west, and north-east, and the drift of the impurities is consequently more towards the east than the west. Of the three constituents of the total suspended matter, the one which is least injurious is the mineral matter. This is abnormally high at the Leeds Forge, and consists principally of oxides of iron, lime, alumina, and silica, either escaping with the fumes from the furnace or thrown out mechanically.

In a former series of experiments the amount of soot deposited was determined by collecting daily from a fresh surface a square yard of snow (which lay for several days), melting, filtering, and weighing the soot. The total deposit on the first day represented 16 cwt. to the square mile, and the daily increase was, on the average, 4 cwt. Taking a four-square-mile area covered by the town, and

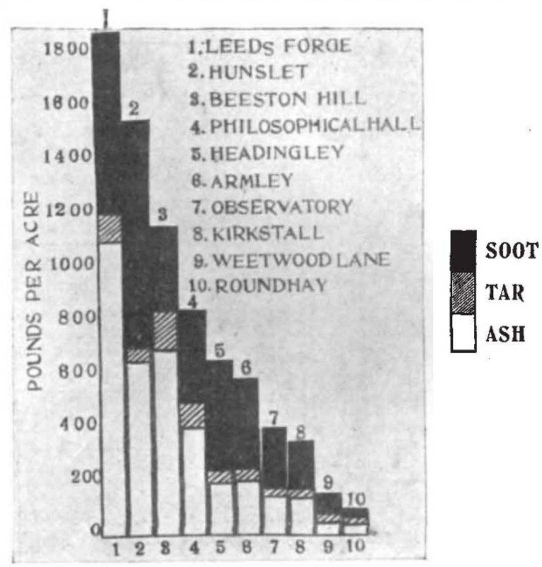



Fig. 1.—Suspended Matter.

allowing for a diminishing fall on the fringe of the area, the amount carried down by the first fall of snow may be represented roughly by 10 cwt. to the square mile, and the daily increase as one quarter of this amount. Later results, as determined from the soot deposited with the rain water, are in close agreement with these figures. The analyses of the total deposit for the whole year show that at Hunslet (industrial centre) the soot amounts to 300 tons per square mile, at the Leeds Forge (industrial centre) to 250 tons, whereas at Woodhouse Moor (one mile north-west of the centre) it dropped to 80 tons. Taking the average of the stations which lie within the central four-square-mile area, we get 190 tons per square mile per year, or roughly half a ton per square mile per day.

The amount of tar deposited with the soot was previously demonstrated by exposing glass plates 1 foot square at different points situated in and at distances from the town. These plates at intervals were washed under running water, and the residual deposit analysed. The amount of soot thus remaining, as determined from its carbon content, was found to be twenty-four times greater in the town than at a distance of nine miles. In the present experiments the tarry matter was estimated by extraction with ether. The quantity dropped from 80 lb. per acre per annum in the centre to 14 lb. per acre at a distance